UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

0061419187

CHEMISTRY **9701/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2010**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
You are advised to show all working in calculations.
Use of Data Booklet is unnecessary.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
Total	

This document consists of **9** printed pages and **3** blank pages.

DC (SLM) 35024

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1 When aqueous sodium chloride, NaCl, is added to aqueous lead nitrate, $Pb(NO_3)_2$, a white precipitate of lead chloride, PbCl_2, is produced. A suggested stoichiometric equation is

$$Pb(NO_3)_2(aq) \quad + \quad 2NaCl(aq) \quad \longrightarrow \quad PbCl_2(s) \quad + \quad 2NaNO_3(aq)$$

In separate experiments, different volumes of 0.20 mol dm^{-3} aqueous sodium chloride are added to a fixed volume of 0.10 mol dm^{-3} aqueous lead nitrate. In each case, the precipitate is filtered, washed with distilled water and thoroughly dried. The mass of the precipitate is recorded.

You are to plan an experiment to investigate this reaction in order to confirm or reject the stoichiometry of the equation.

(a) By considering the suggested stoichiometric equation, predict and explain how the number of moles of the precipitate, PbCl_2, will change as the number of moles of NaCl added increases.

Prediction ....

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Explanation ....

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.... [2]

(b) State a limiting factor that must be taken into account when increasing the volume of the aqueous sodium chloride added.

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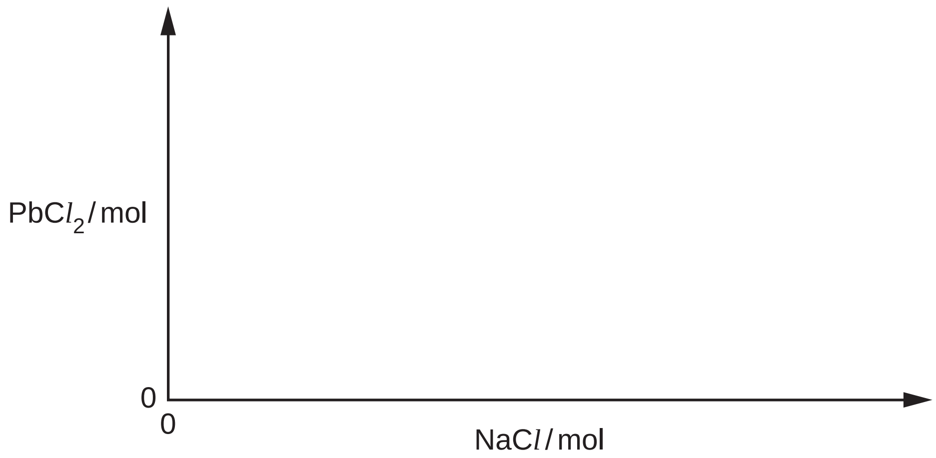
Sketch the graph which would result if, after some of the experiments, the NaCl is in excess. Start your graph with no NaCl added.



[3]

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(c) In the experiment you are about to plan, identify the following.

(i) the independent variable ....

(ii) the dependent variable ....

(iii) another variable to be controlled ....
[2]

(d) Design a laboratory experiment to test your prediction in **(a)**.

You are provided with 250 cm^3 of 0.20 mol dm^{-3} aqueous sodium chloride.

(i) Outline how you would prepare 250 cm^3 of 0.10 mol dm^{-3} aqueous lead nitrate.

[A_r: N, 14; O, 16; Pb, 207]

(ii) Give a step by step description of how you would carry out **one** experiment.
You should state
- the volumes of each solution to be used,
- how the volumes will be measured,
- how you would dry the precipitate.

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(e) In the table below

- enter appropriate headings to show additional data you would record when carrying out your experiments and the values you would calculate in order to construct a graph to support or reject your prediction in **(a)**. The headings should include the appropriate units,
- enter the volumes from your plan in **(d)**,
- enter suitable volumes for four further experiments.

[2]

(f) How would you ensure that at the end of each experiment the precipitate was thoroughly dried?

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.... [1]

[Total: 16]

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2 The melting point of solid water is 0 °C. This is the same as the freezing point of water. This freezing point can be lowered (depressed) by the addition of a solute, such as glucose. The extent of the freezing point depression depends on the **number of particles of solute dissolved** in the solution.
The freezing point depression, ΔT_f, is proportional to the molal concentration, c_m, of the solution.

$$\Delta T_f = K_f c_m$$

where K_f is the freezing point depression constant.

The molal concentration (molality) of a solution is defined as the number of moles of a solute dissolved in one kilogram of water e.g. a one molal solution has one mole of solute dissolved in one kilogram of water.

An experiment was carried out to investigate the relationship between ΔT_f and c_m.

- A weighed sample of distilled water was placed in a boiling tube.
- A weighed sample of glucose was added.
- The mixture was stirred until a solution was obtained.
- The tube was placed in a freezing apparatus to lower the temperature.
- The freezing point of the solution was measured precisely and the freezing point depression calculated.

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(a) Calculate the M_r of glucose $C_6H_{12}O_6$.

[A_r: H, 1.0; C, 12.0; O, 16.0] [1]

(b) The results of the experiment are recorded below.

A	B	C	D	E	F
mass of water / g	mass of glucose / g	freezing point depression ΔT_f / °C			
100	10.0	1.03			
100	12.2	1.26			
100	18.0	2.09			
100	23.3	2.40			
100	27.7	2.86			
100	30.9	3.22			
100	33.1	3.31			
100	38.6	3.98			
100	42.3	4.37			

Process the results in the table to calculate the molality of the glucose solution. This will enable you to plot a graph to show how the freezing point depression, ΔT_f, varies with the molality of the solution.
Record these values to **three significant figures** in the additional columns of the table.
You may use some or all of the columns.
Label the columns you use.
For each column you use include units where appropriate and an expression to show how your values are calculated. You may use the column headings A to F for this purpose. [2]

(c) Present the data calculated in **(b)** in graphical form. Draw the line of best fit.

[3]

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(d) Circle on the graph any point(s) you consider to be anomalous.
For any point circled on the graph suggest an error in the conduct of the experiment that might have led to this anomalous result.

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.... [3]

(e) **(i)** Determine the value of $\Delta T_f / c_m$ from your graph. This is the freezing point depression constant K_f . Mark clearly on the graph any construction lines and show clearly in your calculation how the intercepts were used in the calculation of the slope.

(ii) By considering the data you have processed and the graph you have drawn, decide if the experimental procedure described is suitable for the determination of the freezing point depression constant K_f. Explain your reasoning.

[3]

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(f) When the experiment was repeated using sodium chloride instead of glucose as the solute, the freezing point depressions were found to be twice the value obtained in the glucose experiment for each molality.
Using the information given at the start of the question suggest a reason for this.

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.... [1]

(g) Using your suggestion from **(f)** predict the effect on the freezing point depression if a weak acid such as ethanoic acid was used instead of glucose or sodium chloride as the solute.

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.... [1]

[Total: 14]

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